Effects of Dynamic Strength in the Velocity History of a Rippled Shock
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Research question: How does the dynamic strength of a material affect the velocity of particles at a perturbed shock front and can this be used to estimate dynamic strength in solids?

Abstract:
This work investigates the relationship between the evolution of particle velocity at different locations of a perturbed (rippled) shock front and the dynamic strength of the material by performing careful direct numerical simulations of a several experimental configurations. The findings of this research will further our understanding of dynamic strength effects on the evolution of hydrodynamic instabilities in solids and provide the basis for a potential new technique to evaluate dynamic strength of solids under extreme loading conditions.

Method:
- 2-D, plane strain simulations were performed using a specialized hydrocode.
- The model simulated a stationary rippled copper target, as shown in Fig. 1.
- The target was impacted by a flat flyer plate, made of Tungsten to increase the mean stress.
- The impact occurred on the rippled side of the target, which lead to a perturbed (rippled) shock front propagating towards the flat side of the sample.
- After the shock arrives at the flat surface, the difference between particle velocities predicted at peaks and valleys of the perturbed shock front was plotted versus time.

Results:
- The amplitude of the shock front in the Tungsten to Copper setup was too large, and theory states that large shock perturbation amplitudes are relatively insensitive to effects in strength.
- A setup to fix this insensitivity is to cover the perturbation with a different material [Fig. 2], like Tungsten or Nickel, this will produce a faster shockwave that lowers the amplitude of the rippled shock front, making it more sensitive to strength effects.
- Simulations indicated that Nickel was a good choice to be the base material as Tungsten’s sound speed is too close to Copper’s so the shock arrives almost flat to the target. Nickel also has a faster wave speed than copper, which is also desirable.

Conclusion:
- Impact between Tungsten and Copper produces larger pressures in Copper than the Cu-Cu setup.
- A target thickness of 300 to 500 μm yields the largest velocity difference in the shockwave for the updated configuration. [Fig. 3]
- Fig. 3 and Fig. 4 show how sensitive the experiment is to changes in strength.

Future Work:
- Gas gun at Dr. Peralta’s Lab will be used to run experiments with the updated setup, [Fig. 2]
- Electroplate Nickel to Copper sample.
- Develop a technique to evaluate dynamic strength of solids with alternative methods.

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References:

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